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Juliana Jaramillo ^{ab}; Fernando E. Vega ^c

^a International Centre of Insect Physiology and Ecology (ICIPE), Nairobi, Kenya ^b Institute of Plant Diseases and Plant Protection, University of Hannover, Hannover, Germany ^c Sustainable Perennial Crops Laboratory, United States Department of Agriculture, Agricultural Research Service, Beltsville, MD, USA

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SHORT COMMUNICATION

Aphanogmus sp. (Hymenoptera: Ceraphronidae): a hyperparasitoid of the coffee berry borer parasitoid *Prorops nasuta* (Hymenoptera: Bethylidae) in Kenya

Juliana Jaramillo^{a,b,*} and Fernando E. Vega^c

^aInternational Centre of Insect Physiology and Ecology (ICIPE), P.O. Box 30772-00100, Nairobi, Kenya; ^bInstitute of Plant Diseases and Plant Protection, University of Hannover, Herrenhäuser Strasse 2, 30419 Hannover, Germany; ^cSustainable Perennial Crops Laboratory, United States Department of Agriculture, Agricultural Research Service, Building 001, Beltsville, MD 20705, USA

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This is the first report of a hyperparasitoid of *Prorops nasuta*, a primary parasitoid of the coffee berry borer. *Aphanogmus* sp. is a gregarious ectoparasitoid of larval and pupal stages of *P. nasuta*, which was found in coffee berry samples collected on the ground of an organic coffee plantation in Western Kenya. The hyperparasitoid shows a clear pattern of emergence from year to year, following its host. *Aphanogmus* sp. parasitizes around 10% of *P. nasuta* immature stages under field conditions.

Keywords: organic coffee; coffee berry borer; *Prorops nasuta*; hyperparasitoid; *Aphanogmus*; Africa

The coffee berry borer (CBB) *Hypothenemus hampei* (Ferrari) (Coleoptera: Curculionidae, Scolytinae) is the most important coffee pest worldwide (Damon 2000; Jaramillo, Borgemeister, and Baker, 2006). The insect causes serious economic losses to commercial coffee plantations, and these losses reduce earnings for more than 20 million rural families around the world (Vega, Rosenquist, and Collins 2003). The females bore galleries into the endosperm of the coffee berries causing its premature fall and qualitative and quantitative losses in coffee through feeding of the larvae inside the berries (Le Pelley 1968). *Prorops nasuta* Waterston (Hymenoptera: Bethylidae), first recorded in Uganda in 1923 (Hempel 1934), is an ectoparasitoid of CBB larvae and pupae. In addition it attacks the female beetles and preys on their eggs and young larval stages (Hargreaves 1935). The parasitoid has been recorded from coffee plantations in West, Central and East Africa (Abraham and Moore 1990), and has been also introduced to the Americas and to several Asian countries for biological control of CBB (Barrera, Baker, Valenzuela, and Schwarz 1990; Baker 1999). In Uganda *P. nasuta* numbers in coffee plantations start to increase from April onwards, with peak numbers recorded during June and July, resulting in an effective control of CBB populations (Hargreaves 1926).

*Corresponding author. E-mail: jjaramillo@icipe.org

Here, we report on a new species of *Aphanogmus* (Hymenoptera: Ceraphronidae) (Figure 1) acting as a hyperparasitoid of *P. nasuta* in Kenya. The species description will be published elsewhere (Buffington et al., in preparation).

Starting from October 2006, a non-shaded 2000-tree 15-year-old organic coffee plantation (*Coffea arabica* var. Ruiru 11) (planting density 2×2 m) in the Kisii District of western Kenya ($00^{\circ}25'S$, $34^{\circ}28'E$; 1,510 m above sea level [m a.s.l.]; mean annual temperature $20.6^{\circ}C$; 1712 mm annual rainfall), was sampled on a bi-weekly basis during 2006 and 2007, and weekly during 2008 for natural enemies of the coffee berry borer by collecting beetle-infested berries that had fallen to the ground. Banana and maize crops surrounded the coffee plantation. Kisii is one of the major coffee growing areas in Kenya; coffee in this area is mainly produced by small-scale farmers in an organic manner. Long and short rains take place during the months of March–May and October–November, respectively, leading to the main and secondary harvest 8 months later (October to December and June to August, respectively).

After collection, the berries were taken to the laboratory and placed in square plastic containers ($40 \times 40 \times 20$ cm) with perforated lids (5.5 cm diameter) covered with mesh. The containers were layered with a 1.5-cm mixture of plaster of Paris and activated charcoal to retain the humidity and delay the desiccation of the berries, thereby increasing the survivorship of natural enemies within the berries (Jaramillo, Chabi-Olaye, Poehling, Kamonjo, and Borgemeister, in press). This methodology allowed assessing the emergence of parasitoids from the coffee samples for periods of up to 90 days. So far, 1342 individuals of *Aphanogmus* sp. have been recovered since October 2006 out of 34,772 berries collected from the ground. *Aphanogmus* sp. emergences commenced in both 2007 and 2008 during January and the population peaked around March (Figure 2). No emergence of the hyperparasitoid was recorded from July to December 2007, coinciding with very low prevalence of the *P. nasuta* in the field. In both years, the emergence of the hyperparasitoid started 1 month later than its host *P. nasuta*.

During the dissection of berries we observed that *Aphanogmus* sp. spends most of its time inside the coffee berries within the coffee berry borer galleries. Before

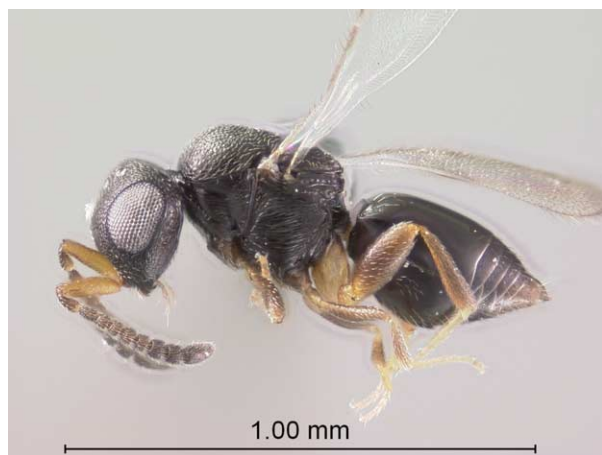


Figure 1. *Aphanogmus* sp. adult.

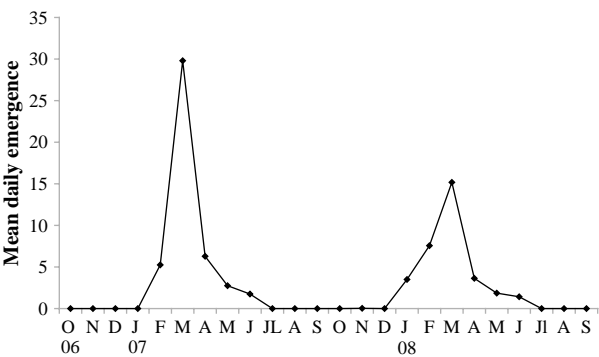


Figure 2. Temporal dynamics of *Aphanogmus* sp. emergence in Kisii, Western Kenya.

parasitising *P. nasuta*, the hyperparasitoid probes with its antennae the older host larvae or pupae just before construction of the cocoons. Around 10% of the total number of *P. nasuta* cocoons inside a single berry were parasitised by *Aphanogmus* sp., and the parasitoid was found in approximately 5–10% of the berries that contained *P. nasuta*. The hyperparasitoid usually oviposits on the abdomen of

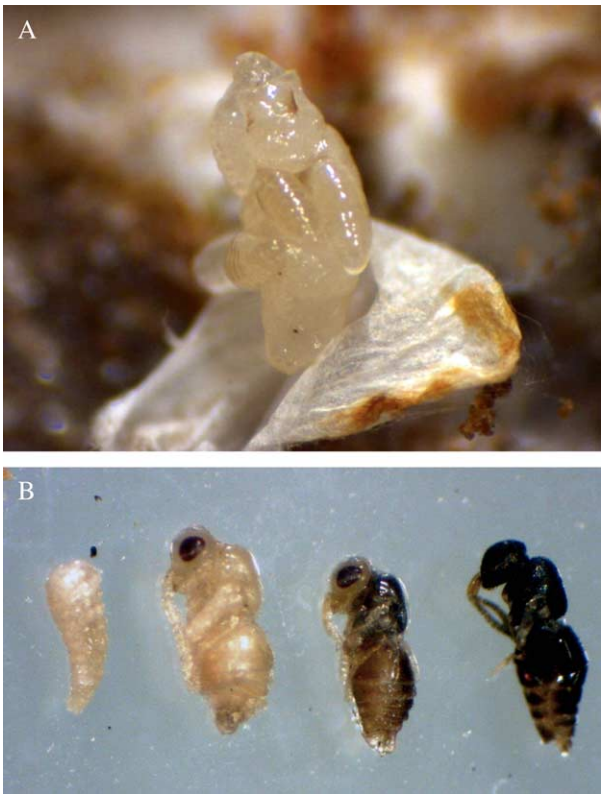


Figure 3. *P. nasuta* pupae hyperparasitised by *Aphanogmus* sp. (A) *P. nasuta* pupa parasitised by *Aphanogmus* sp. (B) Life stages *Aphanogmus* sp.

P. nasuta, and up to three *Aphanogmus* sp. larvae or pupae were found inside the *P. nasuta* cocoons, most often two females and one male, or only two females (Figure 3a,b). The mean size of the young *Aphanogmus* sp. larvae ranges from 0.33 to 0.50 mm, and the older larvae is approximately 0.70 mm long. So far, neither behavioural responses of the larvae as a result of *Aphanogmus* sp. attack nor aggressive behaviour of *P. nasuta* females towards *Aphanogmus* sp. females have been observed during the dissections of the berries.

This is the first report of a hyperparasitoid of a primary parasitoid of the coffee berry borer in the area of origin of the pest. Studies on the biology and ecology of the hyperparasitoid are ongoing to assess its impact on *P. nasuta* populations in the field.

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